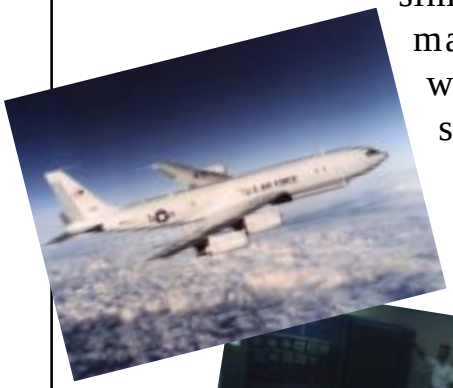
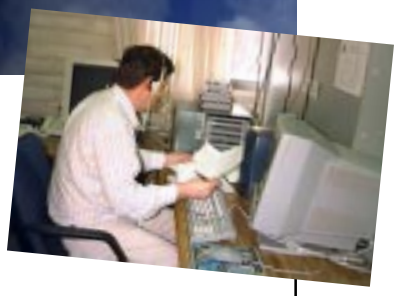
Emerging Findings from JADS!

Distributed testing: linking together test assets to create several new, promising test capabilities. Live, virtual, and constructive blend to create a more complete battlefield, where safety and environmental constraints can be overcome. Distributed testing is inherently different from other distributed simulation applications--and from traditional testing--in many, many ways: JADS has learned this the hard way, through our own distributed tests. Here are some of our more significant emerging findings.

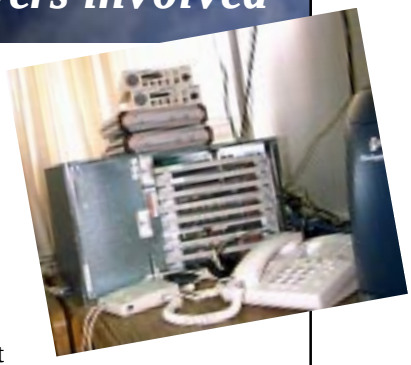


To a certain extent, latency is manageable



The same analysis that leads us to say that distributed is not a function of distance shows us that latency can be managed. The ADS architectural design is the most determining factor of latency. For instance, our routers have a latency of 4 milliseconds one way. If you have three routers in your ADS architecture, you've just added 12 milliseconds of latency. You don't necessarily need three routers - the network engineers might be able to design the network portion of your ADS differently. Network interface units (computers that manipulate data from one format to another) in our tests have imparted latencies varying from 10 milliseconds to over 1 second. Faster computers or a redesign of either hardware or software can reduce that latency.

The effect of latency is dependent on the players involved



Latency is a factor when you are trying to generate closed loop interactions between players. In most testing, the answer to "Do you have an open or closed loop test?" is yes. In any test, there are multiple feedback loops, some of which may be open and some of which will be closed. In the LSP test, we attempted to close the loop between all three players (shooter, target and missile). Because of a number of factors, we were not able to adequately close one of those loops before we had to end the test. We're pretty sure that, given more time and money, that remaining loop could be closed adequately. In the LFP test, we had closed loop interactions between the live shooter and live target on the Gulf Test Range. We did not (nor plan to) close the loop between the missile and the target. Whether that is a problem depends on the real world interactions between missile and target (Can a target aircraft with no warning react to a very fast missile?) and/or the purpose and design of the test event. Most live air to air missile testing is open loop, since the target does a scripted maneuver regardless of what the missile does. Latency is not an issue in replicating those cases.

For more info: http://www.jads.abq.com

For more information on the lessons learned within, see the System Integration Test, Linked Simulators Phase Final Report (Chapter 5) or contact Ms Ann Krause, JADS legacy Manager, at (505) 846-1291 or ann@jads.abq.com. Extensive information is also available from JADS technical and background papers at http://www.jads.abq.com/html/jads/techpprs.htm.

The JADS Joint Test Force is a joint test chartered by the Office of the Secretary of Defense to investigate the utility of Advanced Distributed Simulation for Test and Evaluation.

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First, an observation: it's ADS, not ADSs

Advanced Distributed Simulation (ADS) is a singular term—it's not Advanced Distributed Simulation***s***. That is a key distinction for the test and evaluation community. ADS does not mean link a bunch of constructive simulations together to make a bigger, more complex set of smoke and mirrors—it means mixing live, virtual, and constructive players to give the user the right mix of fidelity and realism to meet specific needs. All of JADS' tests involve linking a combination of live, virtual, and constructive players that have previously met the test and evaluation 'standard'. With ADS, if a constructive model of an aircraft is not sufficient for your test, replace it with a higher fidelity simulator (from the Theater Air Command and Control Facility (TACCSF), for instance) or a hardware-in-the-loop 'aircraft' (perhaps from China Lake) or a full motion flight simulator (from Wright Patterson AFB, for instance) or a live aircraft (maybe at the Eglin Gulf Test Range). The entire environment is the distributed simulation just like the entire range environment is a simulation of the combat environment.

Distributed is not a function of distance

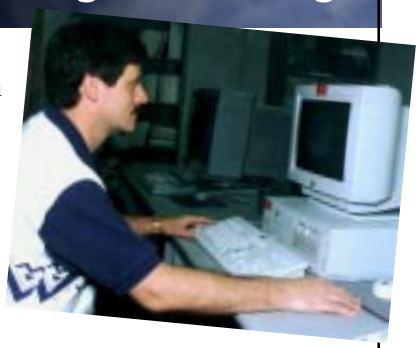
Latency is a function of processing and transmission—and processing latency dominates. Transportation of digital data across distances can be done very quickly compared to the necessary data manipulation required to execute distributed simulation. In preparation for the Linked Simulators Phase (LSP) of our System Integration Test (SIT), we established a surrogate wide area test bed of the LSP test in a room in JADS for network checkout. A ping test across a dedicated non-LSP T-1 line from Albuquerque to Eglin AFB took 48 milliseconds round trip. An identical ping test across the LSP test bed in the room at JADS (to one end and back) took 31 milliseconds - an 8 millisecond one way difference compared to a physical difference of 20 feet to 1200 miles. Likewise, the latency between the LSP node at Pt.Mugu and the node at China Lake (150 miles distant) was 20 milliseconds while the latency between the Pt Mugu node and the Test Control and Analysis Center in Albuquerque (700 miles distant) was 26 milliseconds - a difference of 6 milliseconds. Data travels over our dedicated T-1 lines at about 150 miles per millisecond.

Validating against live data is problematic

The general approach of JADS' tests is to take data from a previously executed live test, replicate that live test in an ADS environment and compare the results. This is essentially validating against live data. There are several problems here: one involves the quality of the live data. It has been said that in M&S nobody believes the data but the modelers and in testing everyone believes the data except the testers who were on the range. Those of you with a testing background fully understand the limitations caused by instrumentation. Test data doesn't reflect what happened, it reflects what was recorded. On our first LFP flight profile, the live test data gave us two choices for the trajectory of the target aircraft - one generated by range instrumentation and one generated by modeling the target trajectory based on the air to air missile seeker telemetry. The AMRAAM experts have decided that we should validate against the target profile generated from seeker telemetry vice the range instrumentation data. That impacts your validation and hence your accreditation of the ADS environment.. Another problem with validating against live data is the lack of data availability, both the breadth of the data and the number of data sets. Often, live test data collection does not capture all the factors to be modeled in an ADS environment. In our EW test, we have been forced to fly to collect our own baseline data because the existing ALQ-131 test data was not robust enough in terms of recording the environment to give us any hope of correlating the ADS data with the

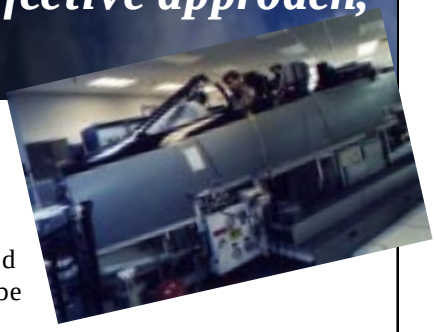
live data. In the LSP and LFP testing, we had one live shot with which to compare our ADS distribution of results. The laws of statistics don't allow you to compare a distribution to a single data point. Hence, we've had to take multiple validation approaches for each of our tests.

Data collection is different from normal testing & training



Generally speaking, an ADS environment is easier to instrument than the traditional live test environment and provides more trials per unit of time. In traditional air to air missile testing, you would typically get one live shot per day. In our SIT LSP testing, we averaged 40-60 'shots' in an 8 hour day while we averaged 5-6 'shots' per hour in the Live Fly Phase (LFP) of SIT. Additionally, you can only collect 24 telemetry streams of data off a live AIM-9 missile while the AIM-9M simulation laboratory provides the same 24 telemetry streams, plus 50 additional sources of simulation data in lieu of your typical range data. When you multiply the number of test events by the availability of data per event, you quickly see how your analysts can get inundated with data. On top of all that, ADS testing requires additional data to be collected on the performance of the networks linking your sites. That data, while not usually used for system under test evaluation, is needed for anomaly assessments.

ADS for T&E <u>alone</u> is not the most cost effective approach, and it may not be cost effective at all.



We have done some cost benefit analysis comparing the AMRAAM Follow-on Operational Test and Evaluation (FOT&E) #3 approach to one that would have included our LFP approach. Our analysis shows that anAMRAAM FOT&E augmented with LFP type of ADS testing could save several live missile shots and recoup the money it would cost to develop and accredit the ADS environment. ***However***, it looks like the real savings will be in creating an ADS environment that has uses across all the acquisition cycles—from requirements development to training and sustainment. That paradigm is included in both Simulation Based Acquisition (SBA) and Simulation, Testing and Evaluation Program (STEP). ADS appears to be a viable enabling tool for both SBA and STEP. The Joint STARS emulation we created to meet the fidelity requirements of our End-to-End test can be used for many aspects of Joint STARS testing that currently require an E-8C in the air radiating live targets (in addition to probable benefits for training and developing requirements and doctrine). The emulation cost approximately $3 million and took 4 years to develop. A cost that is prohibitive when compared to the operational test budget, but is almost below the round off error when compared to the entire Joint STARS program in terms of both dollars and schedule.

ADS allows you to test "differently"

ADS has benefits and shortcomings that we're still exploring. One thing we're pretty well convinced of is that an ADS test (or ADS enhanced test) will look different than what you do (or can do) in a traditional live test. Take the Joint STARS Multiservice Operational Test and Evaluation (MOT&E) as an example. The originally planned MOT&E had an E-8C aircraft flying over the National Training Center at Fort Irwin, California. A comparison of that test and our ETE environment shows that the number of vehicles involved in the live test is 300-500 while the ADS test has 10,000. The enemy rear area in the live test is civilian and commercial traffic on Interstate 10 and in Los Angeles while the ADS test has a doctrinally correct threat laydown of an enemy corps. The time on station availability of the E-8C aircraft is measured in hours while the ADS test 'aircraft' availability is measured in days. The MOT&E was not executed as originally planned due to the system's deployment to Bosnia. The MOT&E was conducted in an actual 'combat' environment and a comparison of that test to an ADS test would have even more differences.